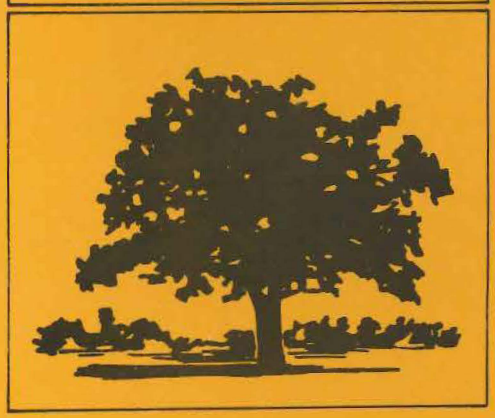

FOREST PEST CONDITIONS IN WISCONSIN

ANNUAL REPORT 1977

DEPARTMENT OF NATURAL RESOURCES
BOX 7921
MADISON, WISCONSIN 53707

PREFACE

Information for this report was contributed by Department forest pest management specialists, foresters and other field personnel. Field personnel in cooperating public agencies and forest industry also contributed to the content.

Our thanks to all of them, to the typists at the Madison Area and Southern District Headquarters, and to the final assembly crew at Pyare Square for bringing everything together into the final product.

Donald W. Renlund, Supervisor
Forest Pest Management

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Department of Natural Resources
Forest Pest Control Personnel - January 1, 1979

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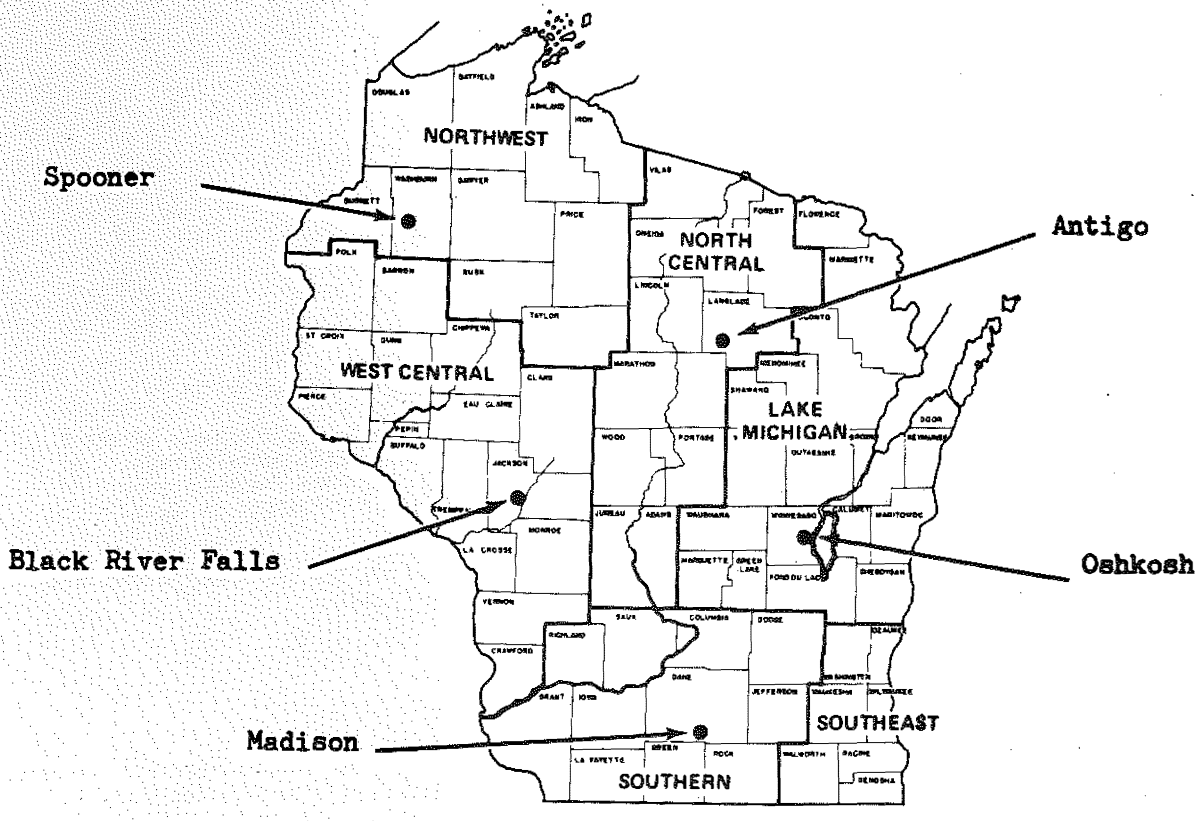

MAJOR FOREST INSECTS

COLEOPTERA

Bronze Birch Borer - *Agrilus anxius* Gory
Forest and ornamental white birch suffering from drought, air pollution and attacked by leaf miners were heavily infested by this borer in the Lake Michigan District.

Twolined Chestnut Borer - *Agrilus bilineatus* (Weber)
The 1976-77 drought placed oaks under severe stress and the exceptionally warm spring provided ideal conditions for twolined chestnut borer development. The result was widespread oak mortality (Figure 1).

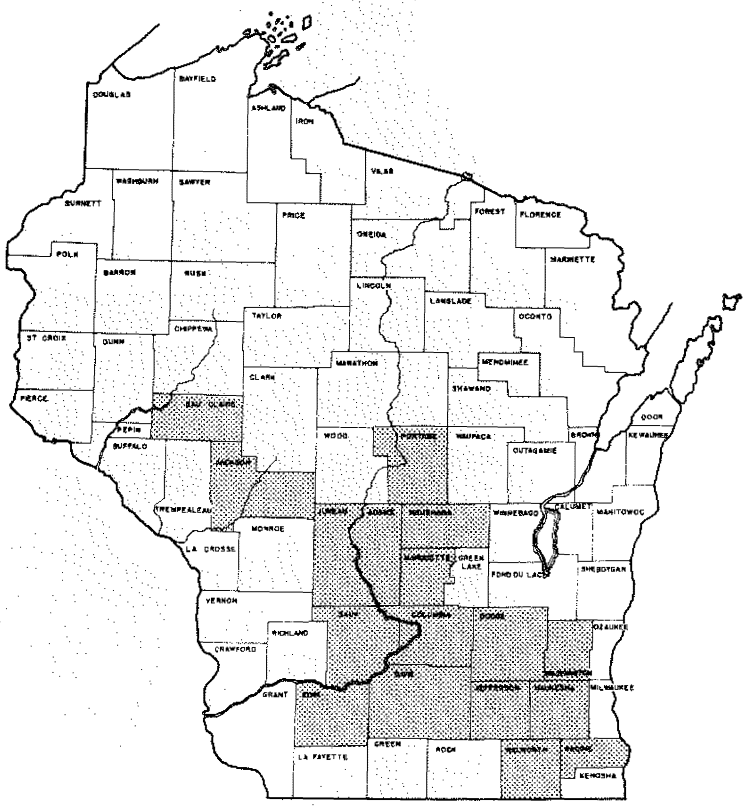

Figure 1. County distribution of twolined chestnut borer and widespread oak mortality.

Tree and branch mortality occurred in scattered patches in dry sandy areas in the Northwest District and on dry ridges in the West Central District. In the Southern District, heavy mortality continued in the Baraboo hills where an outbreak began in 1976. The mortality in 1977 was somewhat reduced in amount and more scattered than in 1976. Mortality continued near Wisconsin Dells and in spots in Dodge and Jefferson counties following cankerworm defoliation.

Heavy mortality occurred in Iowa and Dane counties where damage by the 1976 ice storm was particularly severe. Mortality began showing up in mid July; it normally begins in August.

Phenological Notes:
May 20 - Adults began emerging from caged red oak logs in Madison.
August 10 - Larva excavating pupal chamber.

Wood Borers - *Buprestidae, Cerambycidae*
Numerous wood borers invaded fire-killed pine in Burnett and Douglas counties. Adult Buprestids appeared in early June; Cerambycids in late June. The larvae developed rapidly and were boring deep into the wood by late July.

Numerous pine sawyers, *Monochamus* sp., infested budworm and drought killed balsam in Langlade, Oneida and Lincoln counties.

Pales Weevil - *Hylobius pales* (Herbst)
Minor damage was observed in young red pine seedlings in Adams County.

Pine Root Collar Weevil - *Hylobius radicis* Buchanan
Pine Root Weevil - *Hylobius rhizophagus* Millers
Both species of weevils were present in Scotch pine plantations which suffered some mortality in Burnett and Washburn counties and in red/jack and red/Scotch pine mixed stands in Wood and Adams counties. Root collar weevil caused light mortality in Scotch pine near Blue River in Grant County and in Green Lake, Marquette, Waushara, Waupaca, and Shawano counties.

Pine Engraver - *Ips pini* (Say)
Populations were sharply lower than in 1976 with little early summer pine mortality anywhere in the state. Red and jack pine were attacked in and adjacent to fire damaged timber in Burnett, Douglas, Adams, Wood, and Jackson counties. Late summer mortality occurred in overstocked pole sized red pine plantations in Lincoln, Oneida, Langlade, Wood, Menominee and Vilas counties.

Summer thinnings in pole sized red pines were conducted in Sauk and Eau Claire counties. In Sauk County the residue was attacked by *Ips* but was chipped before the bark beetles emerged. In Eau Claire County, the thinning operation which utilized wood down to a three inch top was conducted throughout the summer and the residue was left on the ground. Bark beetles utilized the stem-wood residue for brood material but emerging beetles did not attack the residual stand possibly because continued cutting provided fresh slash and because of the above-normal rainfall.

Obviously, summer logging operations in pine stands can be safely conducted under the right conditions. We do not yet know enough about these conditions, but they probably involve soil texture, moisture deficit and presence of parasites and predators.

Phenological Notes:
April 27 - Adult males constructing nuptial chambers; females ovipositing in egg galleries in Menominee County.
June 1 - All stages present in slash and log decks at Trout Lake (Vilas County); females ovipositing.

June Beetles - *Phyllophaga* sp.
Adults were observed defoliating oak and aspen in eastern Marathon County. Populations were high in Langlade County measured by the number of complaints of beetles flying in the evenings.

Phenological Note:
May 20 - Adult flight peaked in Langlade County.

Northern Pine Weevil - *Pissodes approximatus* Hopkins
A 40 acre stand of 4 foot red pine in Oneida County (NWNE Sec. 32, T37N, R6E) suffered heavy mortality. The stand was severely damaged by winter injury. Most of the trees attacked and killed were in low spots or frost pockets.

Phenological Note:
June 23 - Larvae in chip cocoons just above ground line.

White Pine Weevil - *Pissodes strobi* (Peck)
Populations were very low throughout the state with only a few weeviled terminals noted.

DIPTERA

Balsam Gall Midge - *Paradiplosis tumifex* Gagné
Populations continued at high levels for the third consecutive year. Heavy infestations were common on planted balsam fir in Forest, Langlade, Lincoln and Oneida counties. Heavy losses were incurred by Christmas tree growers. Damage was common in natural stands in northeastern Langlade and Forest counties. Sticky traps were placed in balsam fir plantations to estimate the numbers of larvae dropping to the ground in late summer. The numbers were high enough that heavy damage is expected again in 1978.

Experimental insecticide treatments were conducted in cooperation with the University of Wisconsin, Department of Entomology. Results are available in Benjamin and Banash (1978).

Red Pine Needle Midge - *Thecodiplosis piniresinosae* Kearby
Pockets of moderately defoliated red pine were noted on edge trees in a 15 year old planting in Marquette County (Sec. 11, T15N, R9E).

HEMIPTERA

Lace Bugs -
An unknown species of lace bug yellowed basswood leaves in Pierce, Dunn and Sauk counties. Lace bugs were numerous on oaks, particularly bur oak in the Lake Michigan District.

HOMOPTERA

Pine Spittlebug - *Aphrophora parallela* (Say)
Generally light infestations occurred on jack and Scotch pine in the northern half of the state.

Saratoga Spittlebug - *Aphrophora saratogensis* (Fitch)
The previously heavy infestations in Burnett County declined to very low levels. Populations elsewhere in the northern half of the state were also very low.

Giant Bark Aphid - *Longistigma caryae* (Harris)
A high population near Arena in Iowa County killed black oak saplings and small limbs on larger trees. High populations were reported on willow and aspen in Dane and Juneau counties.

Balsam Twig Aphid - *Mindarus abietinus* Koch
Light to moderate populations damaged new foliage of balsam fir Christmas tree plantings in Langlade County (NWNE Sec. 29, T31N, R12E; NWSE Sec. 18, T33N, R10E). No other infestations were reported.

Pine Tortoise Scale - *Toumeyella parvicornis* (Cockerell)
Populations were very sparse with only occasional infested pines observed in the northern part of the state.

HYMENOPTERA

Introduced Pine Sawfly - *Diprion similis* (Hartig)
Populations were very low with no noticeable defoliation reported.

A few larvae were collected in Lafayette County - a new county record.

Birch Leafminer - *Fenusa pusilla* (Lepeletier)
Heavy defoliation of white birch occurred in Oneida, Langlade, Lincoln, Waupaca, Shawano, Oconto, Marinette and Florence counties. Lesser amounts were noted elsewhere.

Redheaded Pine Sawfly - *Neodiprion lecontei* (Fitch)
Only a few scattered colonies were found in the northern half of the state.

Red Pine Sawfly - *Neodiprion nanulus nanulus* Schedl
Two local infestations were reported in Columbia County, one at the Game Farm at Poynette and in a private campground (Sec. 1, T10N, R8E). A larval survey in Adams and Wood counties (T20N, R5 & 6E and T21N, R5 & 6E) indicated presence of a very light population.

White Pine Sawfly - *Neodiprion pinetum* (Norton)
Known populations in the southern counties increased from 1976 levels. Noticeable defoliation of white pine was reported in two locations in Grant County (NWSW, Sec. 3, T4N, R3W and NWSE, Sec. 4, T5N, R5W). A small planting of 10-foot white pines were heavily defoliated in Richland County (NESE, Sec. 23, T9N, R1E) and were treated with malathion. Three acres of 10-foot planted white pines were severely defoliated in Crawford County (Sec. 28, T8N, R5W). Planted ornamental white pines at Lake Kegonsa State Park in Dane County were heavily defoliated.

Phenological Note:
May 24 - Larvae beginning to hatch in Grant County (NWSW, Sec. 3, T4N, R3W).

A Redheaded Jack Pine Sawfly - *Neodiprion rugifrons* Middleton
A five acre planting of six-year-old jack pine was heavily defoliated in Jefferson County (SESE, Sec. 9, T5N, R14E).

European Pine Sawfly - *Neodiprion sertifer* (Geoffroy)
Known infestations in Walworth and Racine counties increased greatly in density. New infestations were found in Grant, Iowa, Dane, Waukesha, Walworth and Racine counties.

In the southern unit of Kettle Moraine State Forest (Sec. 10, T4N, R15E) a 40 acre red pine plantation was moderately defoliated with some areas of heavy defoliation. Most red pine plantings had new, very light infestations.

Known infestations continued at low densities in Dane, Rock, and Green counties. A new, very light infestation was found in Dane County (Sec. 2, T8N, R7E).

Light to moderate defoliation of Scotch pine Christmas trees in Grant County (Sec. 15, T6N, R4W) rendered 700 trees unsalable.

Phenological Notes:
April 17 - eggs began hatching at LaGrange in Walworth County (Sec. 10, T4N, R15E)
April 18 - eggs hatching at Blue Mounds in Iowa County (Sec. 1, T6N, R5E)
April 27 - larvae in first and second instar in Dane Co. (Sec. 6, T7N, R8E)
April 29 - larvae 90% first instar 10% second (Sec. 10, T4N, R15E)
May 24 - all larvae finished feeding, dropped to ground (Sec. 6, T7N, R8E), most larvae have dropped (Sec. 1, T6N, R5E)

Larch Sawfly - *Pristiphora erichsonii* (Hartig)
Heavy defoliation of many tamarack stands occurred in the northern half of the state, particularly in Bayfield, Douglas, Sawyer, Washburn, Clark, Forest, Langlade, Oneida, Vilas, Oconto and Marinette counties. Spots of moderate defoliation occurred in Marquette County.

Mountain Ash Sawfly - *Pristiphora geniculata* (Hartig)
Populations were generally low throughout the state. Light to moderate defoliation of ornamentals was observed in Spooner and Hayward.

Blackheaded Ash Sawfly - *Tethida cordigera* (Beauvois)
A substantial local infestation was observed in the City of Fond du Lac.

LEPIDOPTERA

Pecan Leaf Casebearer - *Acrobasis juglandis* (LeBaron)
Populations were nearly undetectable in black walnut plantings throughout the state.

A Walnut Shoot Borer - *Acrobasis* sp.
Specimens reared from walnut shoots previously thought to be A. *juglandis* are probably a new species. Specimens were reared from walnut shoots collected in Green, Dane and Trempealeau counties.

Fall Cankerworm - *Alsophila pometaria* (Harris)
Populations were greatly reduced in Sauk, Columbia, Dodge and Jefferson counties. A few pockets of noticeable defoliation were observed near Lodi, Portage, and Wisconsin Dells. Populations of the predacious beetle *Calosoma calidum* were again very high in areas defoliated for the second year.

Oak Webworm - *Archips fervidanus* (Clemens)
Webs were common on scrub oak in parts of Burnett, Douglas and Bayfield counties.

Solitary Oak Leafminer - *Cameraria hamadryadella* (Clemens)
Mining of white oak leaves was noticeable over the entire southern district. Usually only the lower parts of the crown were attacked. Local areas of extremely heavy mining occurred in Richland and Dane counties and in New Glarus Woods State Park in Green County.

Large Aspen Tortrix - *Choristoneura conflictana* (Walker)
Larvae were present at very low levels in aspen in the northern third of the state. Spots of moderate defoliation of aspen were observed in Lincoln (T35N, R4,5,6E) and Langlade (T33N, R9E; T31N, R9,10E) counties.

Spruce Budworm - *Choristoneura fumiferana* (Clemens)
The northeastern infestation increased in area to approximately 140,000 acres (Figure 2) in eastern Vilas, most of Forest and Oneida and western Florence counties. Isolated pockets of light defoliation (not on map) occurred in Langlade, Lincoln, Oconto, Florence and Marinette counties. Based on aerial and ground surveys, 20,000 acres were heavily defoliated, 90,000 moderately defoliated and 30,000 lightly defoliated.

Egg mass counts were 1.93 per 15 inch branch, up from 1.20 in 1976. Egg parasitism dropped from 37% in 1976 to 13% in 1977.

Defoliation is expected to increase in severity in 1978 especially from northeastern Oneida County to central and northern Forest County.

In the northwest, feeding was light and scattered on spruce-fir stands in Washburn and Douglas Counties. Egg surveys were negative. Moderate to severe defoliation and some tree mortality continued in Sec. 35, T44N, R8W, Bayfield County. In northern Sawyer County, some light to moderate defoliation occurred. Moderate to heavy defoliation occurred again on over a thousand acres of spruce-fir type in Iron County. Egg counts were lower in most stands sampled, so populations should decrease in 1978.

Phenological Notes (apply to the northeastern infestation):
May 9 - White spruce buds showing no sign of new growth. Balsam buds just beginning to break dormancy. High populations of budworm larvae mining in needles of both species.
May 31 - Stages present: 5th instar - 20%; 6th instar - 66%; pupae - 14%.
June 21 - Only adult moths were observed mating or ovipositing.

Jack Pine Budworm - *Choristoneura pinus* Freeman
Budworm populations sank to a 25 year low in previously heavy infested areas of the Northwest District. Early larval counts were low. Larval parasites in the genus *Apanteles* were numerous and reduced the population even further. Late larval and pupal counts were at an all time low. One hundred twenty-six of the 150 regular survey plots had zero pupal counts. No noticeable defoliation occurred anywhere in the state.

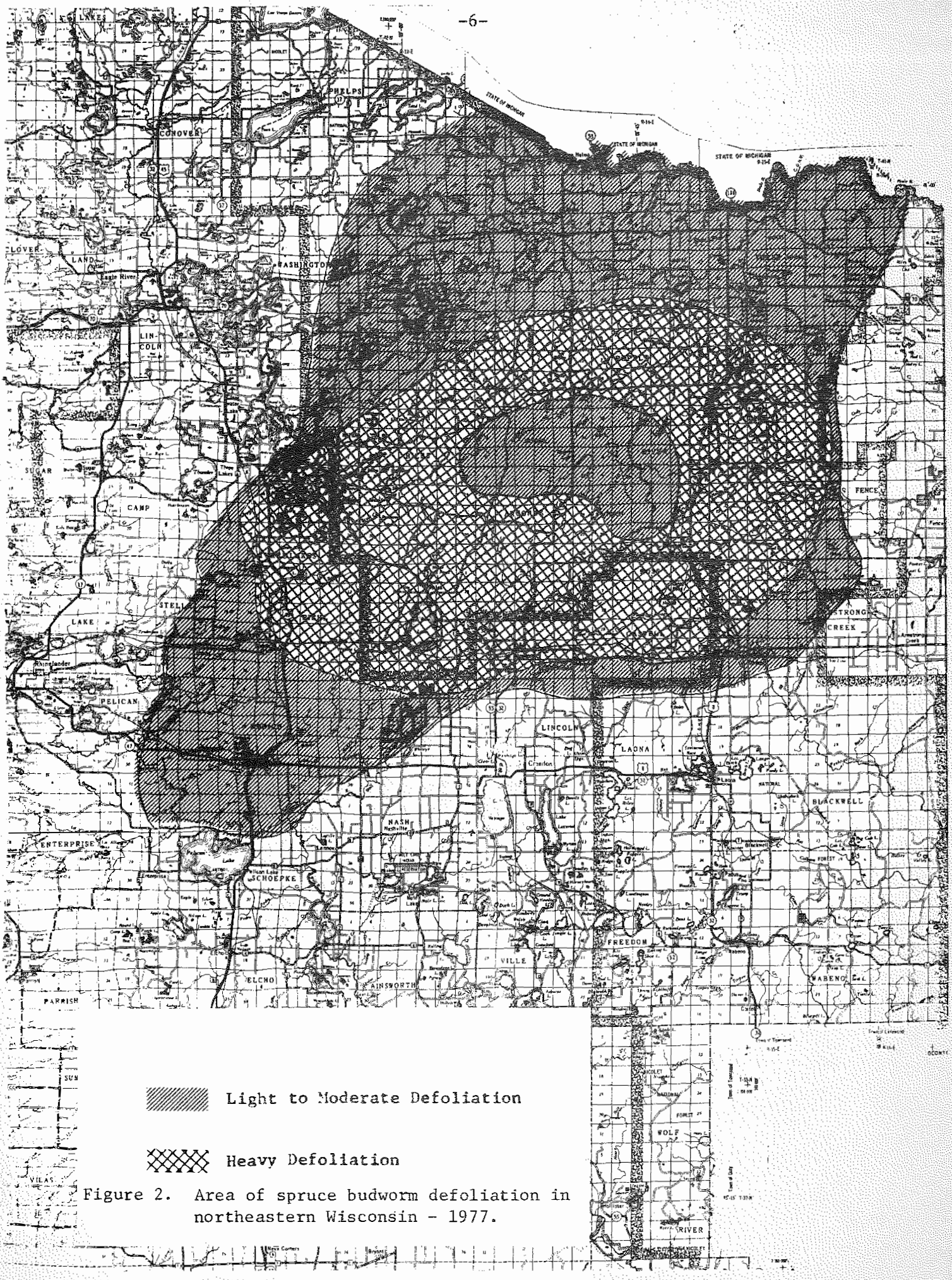

Figure 2. Area of spruce budworm defoliation in northeastern Wisconsin - 1977.

Phenological Notes:

May 13 - Larvae starting to break hibernation in Washburn and Douglas counties. Jack pine leaders 3" to 8" long. Pollen starting to ripen. Oak buds starting to break.
May 16 - Budworm larvae 2nd instar and feeding in western Douglas County. Jack pine leaders 4" to 12" long. Pollen ripened and gone.
May 17 - Budworm larvae out and feeding in Bayfield County. Jack pine leaders 3" to 8" long. Pollen ripe and mostly gone.
May 18 - Some 3rd instar larvae in Burnett County.
May 24 - Budworm larvae mostly 3rd instar in Bayfield County.
June 1 - Larvae in 3rd, 4th and 5th instars in western Douglas County.
June 3 - Majority of larvae in 4th and 5th instars in Washburn County.
June 6 - Larvae 40% in 2nd instar; 50% in 3rd instar; 10% in 4th instar in Vilas and Oneida counties.
June 9 - Majority of larvae in 4th and 5th instars in Bayfield County.
June 10 - Larvae starting to pupate in Polk, Burnett, Washburn and Douglas counties.
June 20 - 90% pupated.
July 1 - Pupation completed, adults present and some eggs found.
July 15 - Most eggs laid and many already hatched.

Oak Leaftier - *Croesia semipurpurana* (Kearfott)
Previous outbreak populations collapsed completely on the Menominee Reservation. Only an occasional curled leaf could be found.

Pine Tussock Moth - *Dasychira pinicola* (Dyar)
The expected population increase in Burnett, Washburn and Douglas failed to materialize. Only a few scattered larvae and no eggs were found.

Zimmerman Pine Moth - *Dioryctria zimmermani* (Grote)
Abundant larvae in a red pine plantation near Millston in Jackson County for the third consecutive year have stunted tree growth.

Larvae also caused heavy damage to red pine, Scotch pine and Douglas fir near Waterloo in Jefferson County.

Greenstriped Mapleworm - *Dryocampa rubicunda* (Fab.)
Numbers were very low in the northern hardwood forest. A few moths were reported in the spring. No defoliation was reported.

Pine Needleminer - *Exoteleia pinifoliella* (Chambers)
Only a few mined needles were present on jackpine in areas that were heavily attacked in 1976. No new areas were located.

Saddled Prominent - *Heterocampa guttivitta* (Walker)
The heavy infestation in Door County remained generally high but began to decline. The population at Newport State Park remained high. The population on Washington Island was lower than in 1976. The population on Rock Island collapsed. Calosoma beetles were numerous in all the infestations.

Fall Webworm - *Hyphantria cunea* (Drury)
Populations continued at very low levels throughout the state. Occasional webs were noted on tag alder, ash, oak and elm in Washburn, Douglas and Sawyer counties.

Gypsy Moth - *Lymantria dispar* (Linnaeus)
All or parts of 33 counties considered most susceptible to gypsy moth introduction were trapped by USDA-APHIS (PPQ) using disparlure baited traps at a density of one trap per 3 square miles (Figure 3). State DNR and Department of Agriculture personnel trapped high use recreation areas throughout the state.

One adult male gypsy moth was trapped on the grounds of the Midcontinent Railroad Museum at North Freedom in Sauk County. Five were caught in four different sections near Oconomowoc in Waukesha County. Intensive trapping in Appleton yielded 26 males in 11 traps. This was the third consecutive year of one or more multiple catches in Appleton.

Eastern Tent Caterpillar - *Malacosoma americanum* (Fab.)
Many local populations erupted from very low numbers in 1976 to extremely high in 1977 in the southern third of the state. The highest populations occurred in Dane, Walworth, Rock, Winnebago and Waushara counties. A few smaller black cherry trees that had been completely defoliated were dead by mid summer.

Forest Tent Caterpillar - *Malacosoma disstria* Hubner
Moderate defoliation of aspen occurred on about 5,000 acres in Douglas County (T46 and 47N, R10 and 11W). Eggs were common and the populations were expected to increase in 1978. Two small pockets of heavy defoliation occurred in Oneida and Langlade counties. Scattered individual larvae and occasional colonies were observed in many northern counties.

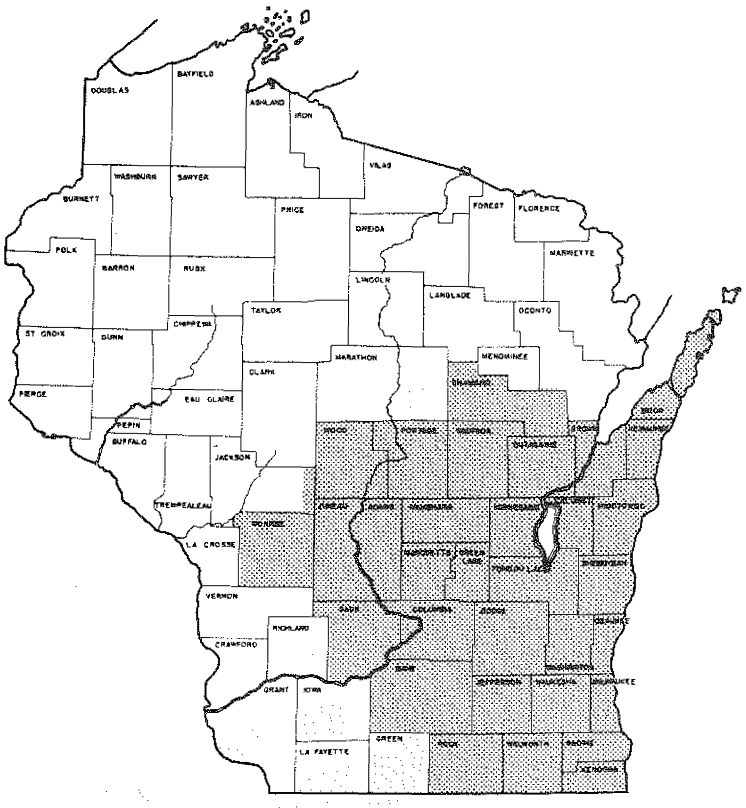

Figure 3. Gypsy moth trapping with disparlure-baited traps in Wisconsin - 1977.

Mourningcloak Butterfly - *Nymphalis antiopa* (L.)
Numerous colonies were observed on aspen, willow and small elm in Langlade, Lincoln, Marathon, Shawano, Waupaca, Outagamie and Winnebago counties.

ORTHOPTERA

Walkingstick - *Diapheromera femorata* (Say)
No defoliation was observed but scattered individuals were observed in Douglas, Bayfield, Eau Claire, Clark, Jackson and Marinette counties.

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1977. A preliminary list of Wisconsin Lepidoptera reared in conjunction with the gypsy moth, *Lymantria dispar* (L.), parasitoid recovery program. Univ. Wis.-Madison For. Res. Note 205.

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1977. New Wisconsin records of Lepidoptera reared in conjunction with the gypsy moth (*Lymantria dispar* (L.)) parasitoid recovery program. Univ. Wis.-Madison For. Res. Note 208.

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MAJOR FOREST DISEASES

WILTS AND DIEBACKS

Oak Wilt - *Ceratocystis fagacearum* (Bretz) Hunt
There was no change in the state-wide distribution of oak wilt in 1977 (Figure 4).

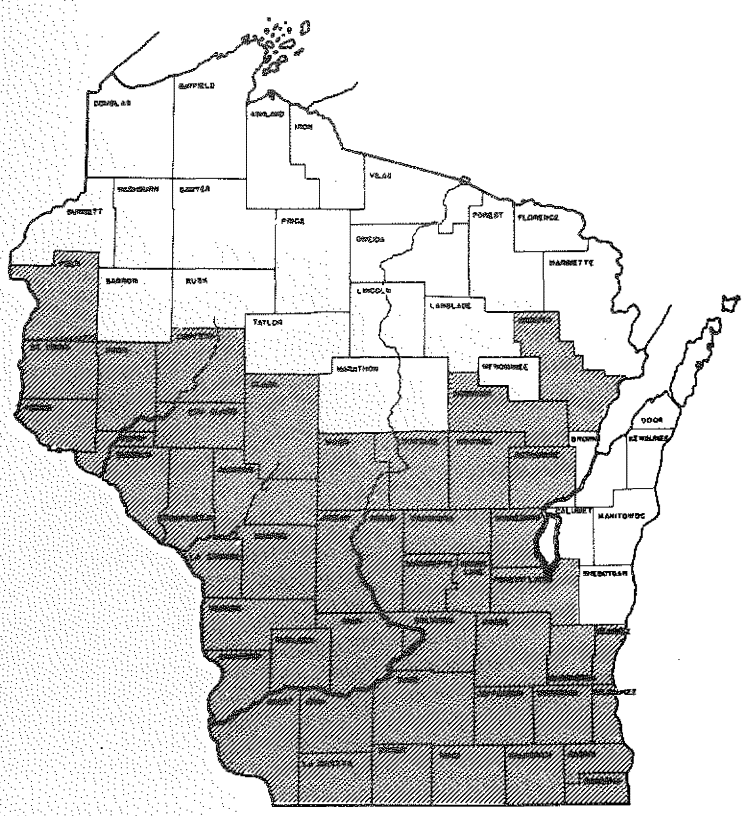


Figure 4. Known distribution of oak wilt in Wisconsin - 1977.

Dutch Elm Disease - *Ceratocystis ulmi* (Buismar) Moreau
Dutch elm disease continued to be the major tree disease problem in Wisconsin. Increased mortality was reported in northwestern Wisconsin cities and villages. Dead and dying trees were common in farm woodlots and along rivers and streams throughout northern Wisconsin.

Wisconsin Department of Agriculture personnel pheromone-trapped the smaller European elm bark beetle in nine counties when they had not been previously recorded (Figure 5). This Dutch elm disease vector has now been trapped in 46 Wisconsin counties.

Aspen Shoot Blight - *Venturia* spp.
Was common on trembling aspen reproduction in northwest Wisconsin but did not appear to be a serious problem.

STEM AND BRANCH DISEASES

Butternut Canker - *Sirococcus sp.*
Surveys continued on the distribution and impact of butternut canker in Wisconsin. In cooperation with the North Central Forest Experiment Station, an attempt was made to trap spores of the canker inciting fungus (tentatively identified as *Sirococcus sp.*) at three locations in Wisconsin (Appendix A). Data were also collected on precipitation and host phenology.

Six microscope slide spore traps were coated with petroleum jelly and changed weekly from April to October (at the Coulee Experimental Forest (LaCrosse County) and Blue Mound State Park (Dane County)). Spore traps were also changed periodically from November 1976 through March 1977. Spore traps were also placed under butternut trees with dying branches in 1977 at Thunder Mountain State Park (Marinette County), in northeastern Wisconsin where butternut canker has not been observed.

Spore trapping results indicated that rainfall was necessary for spore release to occur. Spores were apparently rain splashed and wind disseminated as far as 150 feet from the nearest infected trees. Germinating spores were found on spore traps the weeks of May 10, July 26, and August 23, 1976. Spores were also trapped in the winter from November, 1977 to March, 1978 (Figure 6). Circumstatial evidence

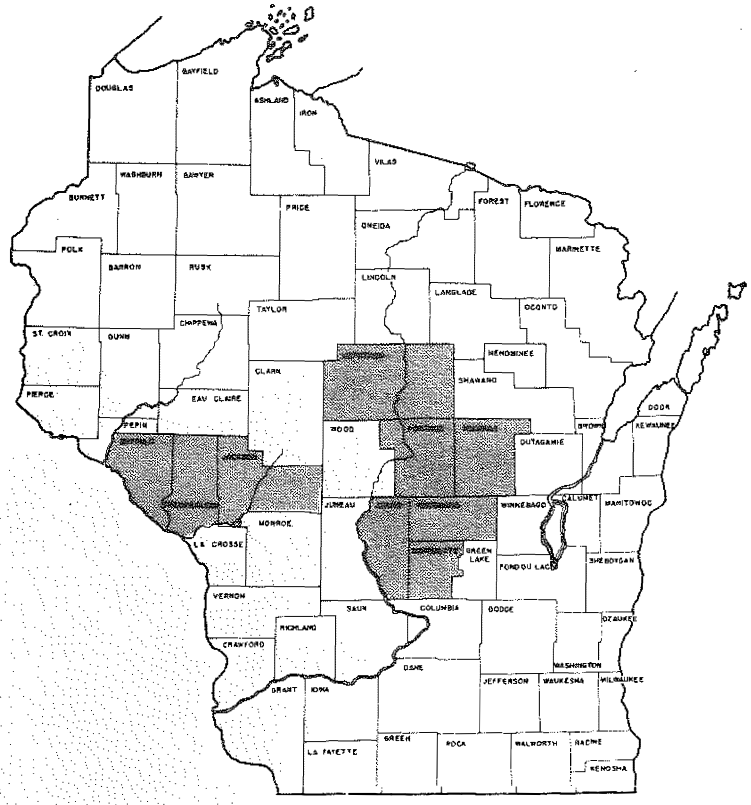


Figure 5. New county records of the smaller European elm bark beetle in Wisconsin - 1977.

indicated that insects may also assist in disseminating spores. During the week of June 7, 1976, a spore trap placed in an opening at Blue Mound State Park had 97 spores in a cluster associated with many parts of an insect's body. There were several other instances where clusters of spores were found on spore traps not directly under infected trees that could only be explained by a raindrop full of spores landing on a trap or an insect vector caught on a trap, or perhaps both.

In many areas where butternut canker is present, the dying portions of trees were rapidly colonized by a secondary invading fungus, *Melanconis juglandis* (E. & E.) Graves. The spores of the imperfect stage of this fungus, *Melanconis oblongum*, were also counted on the spore traps. Maximum *M. oblongum* spore production occurred in May, June and July, although some spores were released throughout the April to October period. Rainfall was necessary for spore release to occur. No *Sirococcus* spores were trapped at Thunder Mountain State Park in northeastern Wisconsin where the canker has not been observed. However, 808 *M. oblongum* spores were trapped indicating its presence on dead branches on butternut trees in that area.

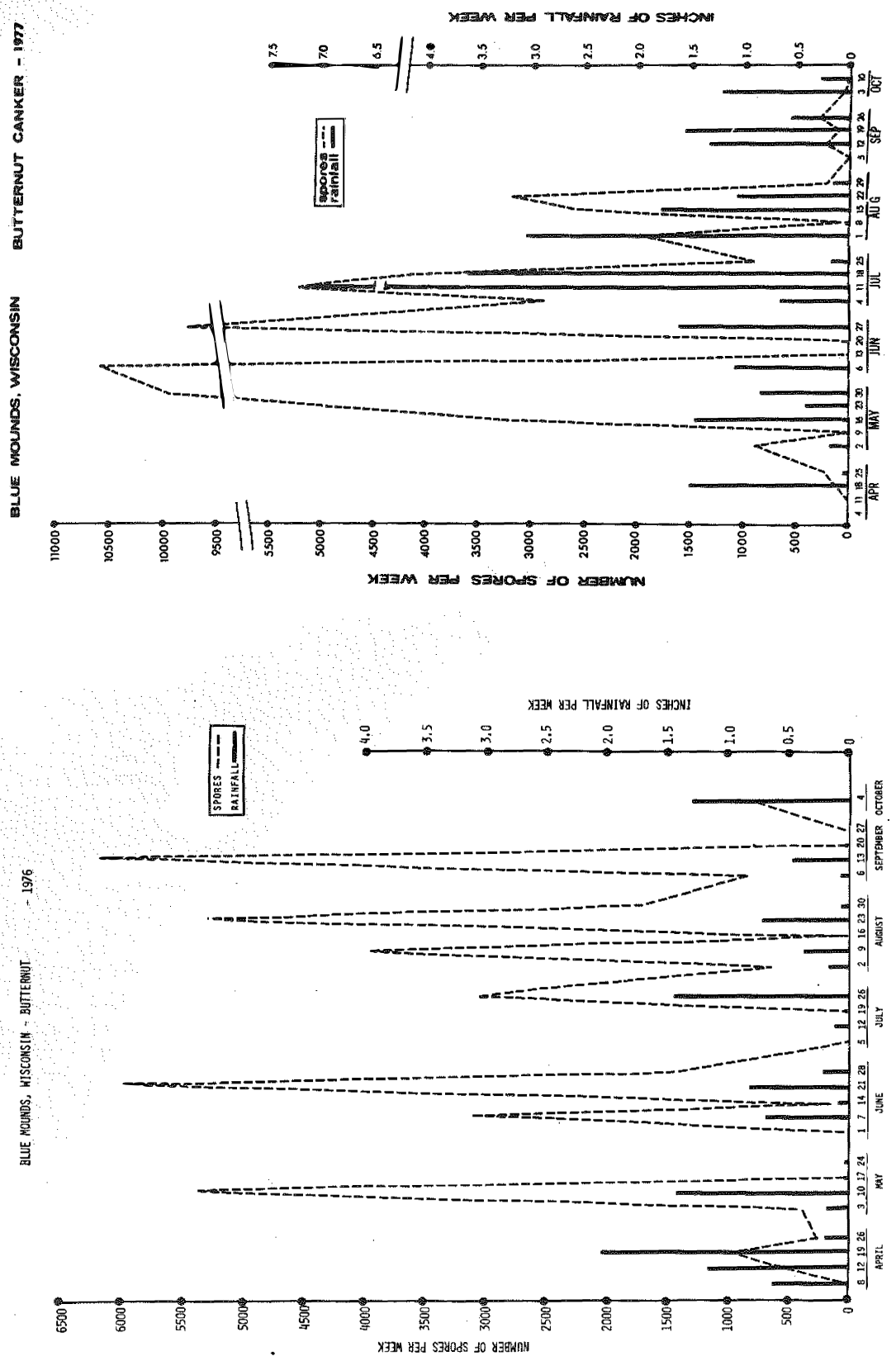


Figure 6a. Butternut canker (Sirococcus sp.) spore trapping - Blue Mounds 1976-1977.

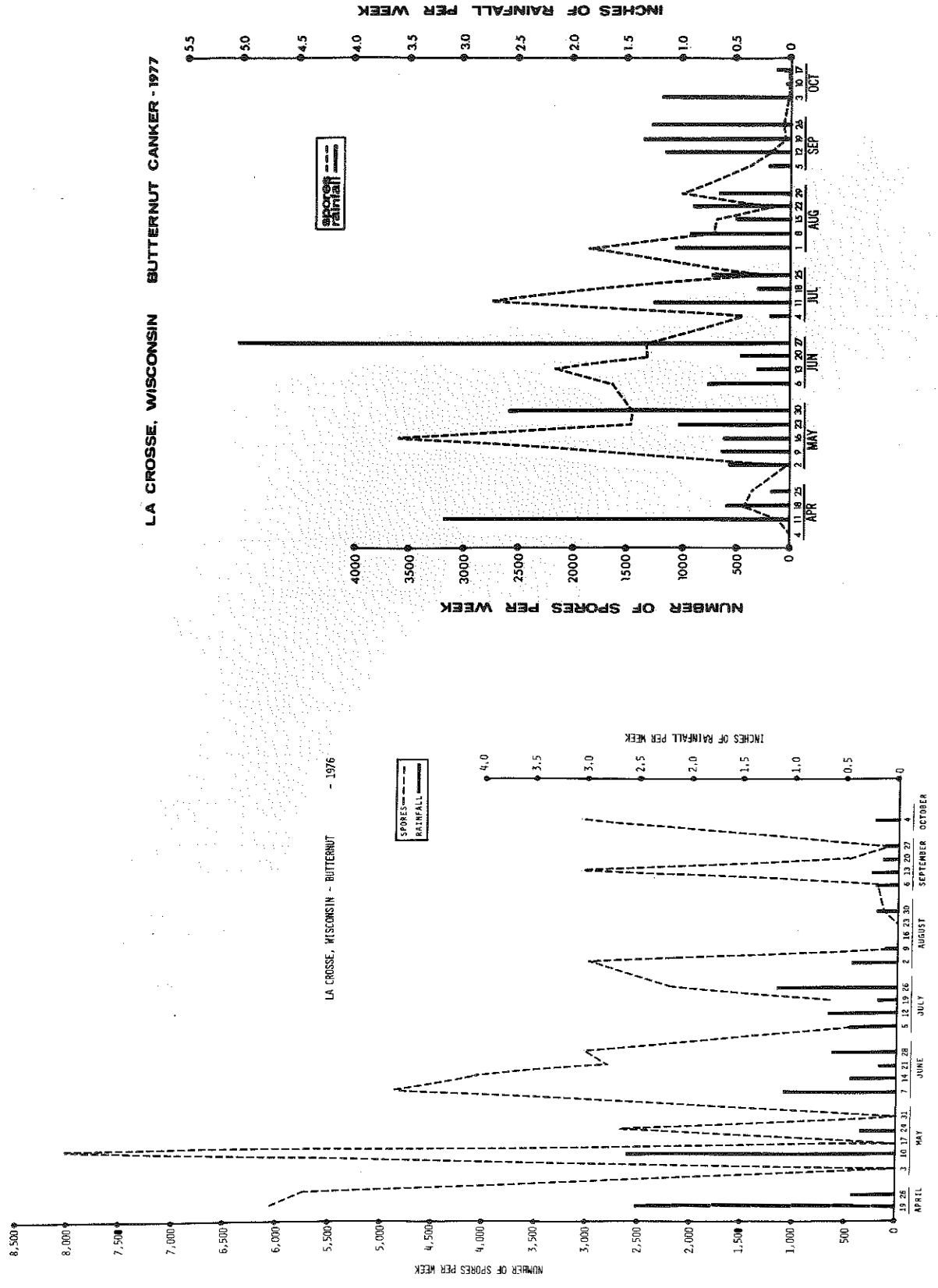


Figure 6b. Butternut canker (Sirococcus sp.) spore trapping - La Crosse 1976-1977.

Diplodia Canker - *Diplodia pinea*
In 1976, several red and jack pine plantations were infected with Diplodia canker and shoot blight in Adams, Bayfield, Douglas, Green, Richland and Wood counties. More than 5,000 acres of native and plantation red and jack pine were infected west of Millston (T20N, R3W) in Jackson County. Survey plots established in the area revealed that some trees infected in 1976 died in 1977. However, the fungus did not infect adjacent trees in 1977.

New locations of Diplodia canker on red and jack pine were observed in Bayfield and Douglas counties where infection appeared to be associated with wounds caused by a hailstorm in 1976. Diplodia canker was also observed on red pine in Green and Waukesha Counties (Table 1). As of 1977, *Diplodia pinea* had been collected in 15 different counties in Wisconsin (Figure 7).

Table 1. New locations of *Diplodia pinea* in Wisconsin - 1977.

Host	Location	County
Red pine	SWSE, Sec. 24, T45N, R11W	Douglas
Red pine	NWNE, Sec. 3, T44N, R11W	Douglas
Red pine	Sec. 31, T46N, R9W	Bayfield
Red pine	NENE, Sec. 11, T1N, R6E	Green
Red pine	SWSE, Sec. 28, T5N, R17E	Waukesha
Jack pine (Collected 7-27-76)	SENW, Sec. 17, T32N, R19E	Marinette

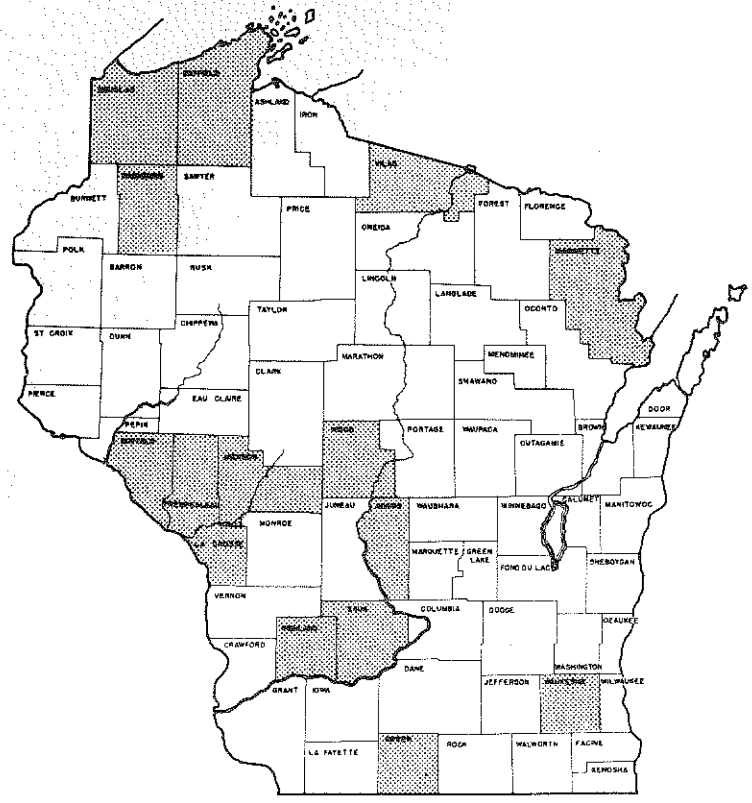


Figure 7. Known county locations of *Diplodia pinea* in Wisconsin - 1977.

Studies on the life history and control of *Diplodia pinea* on red and jack pine that were initiated in 1976 continued in 1977 (Appendix A). Information was gathered on spore dispersal, host phenology and weather data at sites on Black River State Forest in Jackson County (jack pine), Brodhead in Green County (red pine) and Griffith Nursery in Wood County (red pine). Results are displayed in Figure 8.

Results of Diplodia canker and shoot blight observations were presented at the 69th Annual Meeting of the American Phytopathological Society held at Michigan State University, from August 14-19, 1977 (Appendix B).

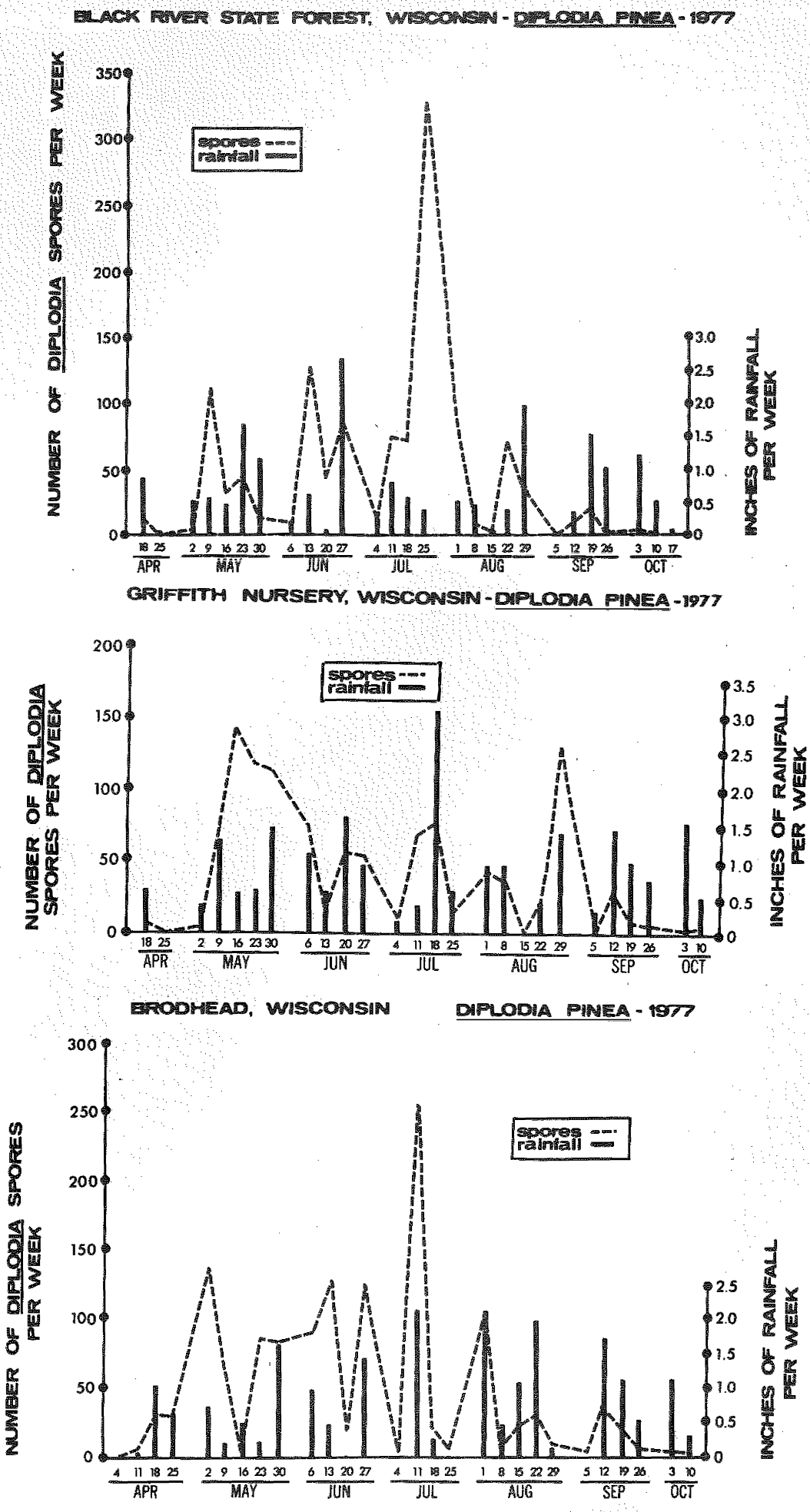


Figure 8. Diplodia pinea spore trapping at three study sites - 1977.

Red Pine Shoot Blight - *Sirococcus strobilinus* (Pruess)
There was no change in the state-wide distribution of red pine shoot blight in 1977 (Figure 9).

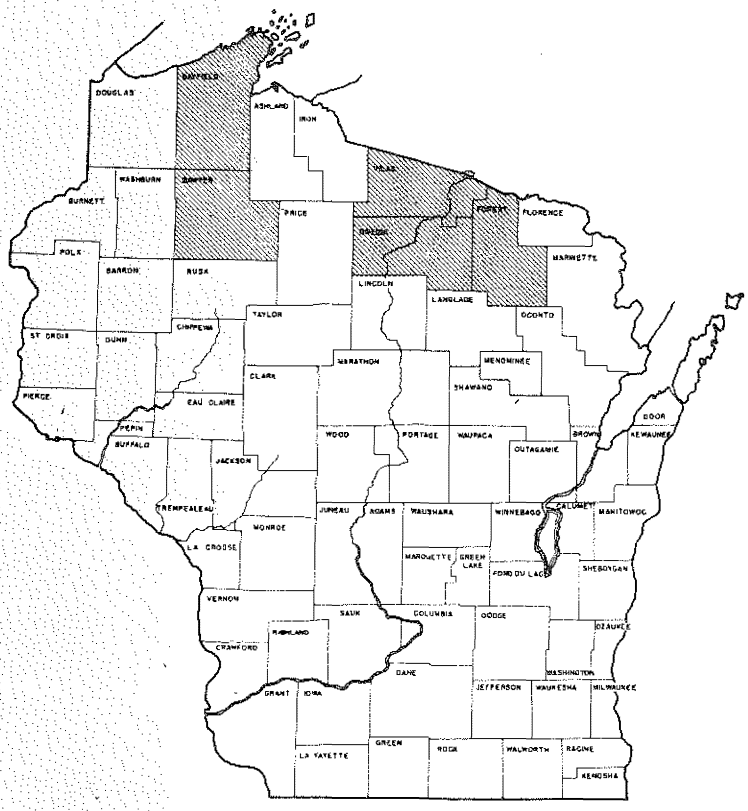


Figure 9. Known county distribution of red pine shoot blight - 1977.

Observations made in survey plots in Vilas County indicated the intensity of red-pine shoot blight decreased, probably due to the drought in 1976 and early summer of 1977. New flagging of red-pine shoots was negligible in the plots established at Starret Lake and other locations in Vilas County. There was a slight increase in the number of trees killed in the understory while there was no mortality to open grown plantation trees (Table 2).

Table 2. Cumulative Tree Mortality[1/], Starrett Lake Red Pine Shoot Blight Plot, Northern Highland State Forest, Vilas County, Wisconsin (Sec. 24, T41N, R7E).

Year	Openings (%)	Understory (%)
1972	0	20
1973	0	31
1974	0	45
1975	0	59
1976	0	63
1977	0	67

[1/]Plot totals: Number of trees in openings - 49
Number of trees in understory - 51

Scleroderris Pine Canker - *Scleroderris lagerbergii* Gremmen
In 1976 a new and possibly more virulent strain of Scleroderris pine canker was identified in New York and Vermont. The new strain was different from any other currently known in North America but was similar to one that has caused extensive damage to conifers in European countries. Because of this, the State of Minnesota imposed a quarantine prohibiting importation of all species of pine with or without roots from these two states. That included nursery stock, Christmas trees, wreaths, cones, branches or twigs used for ornamental purposes.

Wisconsin entomologists and pathologists made a field visit to sites in New York State where U.S. Forest Service Pathologists reported that *Gremmeniella abietina (Scleroderris lagerbergii)* was damaging and killing red and Scotch pine on about 34,000 acres in nine northern counties. A total of 2,300 acres of 30-40 year old pine were already dead. They were concerned that the new strain which kills pine of all ages might spread west and infect red, jack and Scotch pine in the Lake States.

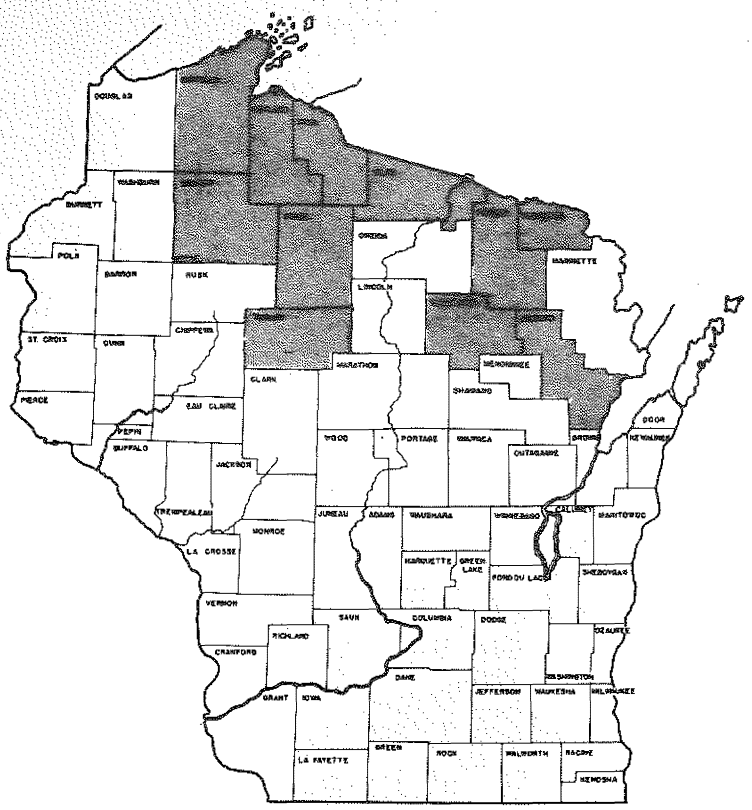


Figure 10. Known county locations of Scleroderris pine canker in Wisconsin - 1977.

The Scleroderris quarantine in Minnesota prompted a meeting of Wisconsin Department of Natural Resources' Forest Pest Control Advisory and Steering Council. The Council comprised of professional foresters, entomologists, and plant pathologists representing Industry, University, Federal and State Agencies approved the following position statement:

ADDENDUM to the Minutes of the Forest Pest Control Advisory and Steering Council

QUARANTINE POSITION STATEMENT WITH RESPECT TO
THE SCLERODERRIS CANKER OF CONIFERS

"The Wisconsin Department of Natural Resources' Forest Pest Control Advisory and Steering Council at its May 10, 1977, meeting at Wausau studied the potential impact of the Scleroderris canker, *Gremmeniella abietina (Scleroderris lagerbergii)*, to conifers growing in Wisconsin. The Council reviewed the state situation from 1965 when areas in the northern part of the state were found to be infected with *Scleroderris lagerbergii* up to the present time.

The Council regards the promulgation of a Wisconsin exterior quarantine to be unwarranted at this time. More information has to be obtained about the North American distribution of the new strain. Environmental conditions that favor infection and cause epidemics to develop should be investigated. The North Central Forest Experiment Station, U.S. Forest Service, is actively studying and researching the Scleroderris situation in New York, Vermont and the Lake States. Additional facts obtained by them should be evaluated before Wisconsin reconsiders the establishment of a quarantine."

May 10, 1977

H. C. Coppel, Chm.
Robert G. Doerner
James E. Kuntz
Howard S. Lovestead
Robert A. Petry
Milton E. Reinke
Donald W. Renlund
Philip W. Smith

An action plan was also formulated to inform state foresters of the potential impact of the European strain of Scleroderris in Wisconsin and surveys were initiated by the DNR Forest Pest Section for the presence of the European strain of Scleroderris.

A scleroderris pine canker survey was conducted in red pine plantations on non-federal lands in Bayfield and Douglas counties. Plantations surveyed were those examined in 1967. One new infected plantation was found near Iron River, Wisconsin (SW¼, Sec. 4, T47N, R8W). Red pine shoot blight (*Sirococcus strobilinus*) was also present in the plantation. Tree mortality continued in three previously infected plantations north of Washburn (NWNW, Sec. 4, T49N, R5W; E½, Sec. 35 & SWSE, Sec. 36, T50N, R6W). Isolations from the infected plantation were tested for European strain of Scleroderris by the North Central Forest Experiment Station. To date, the European strain has not been found in Wisconsin. The known distribution of Scleroderris canker appears to be limited to the northern one-third of Wisconsin (Figure 10).

MISCELLANEOUS

Drought

The effects of the severe moisture shortage in 1976 were still being noticed in the forests during 1977. Red pine plantings continued to die in many areas and natural jack pine and balsam were also affected throughout northwestern Wisconsin.

Aspen Mortality - Drought?

Mortality was observed in a 14 year old aspen sucker stand in early June on Owens-Illinois land in Lincoln County (Sec. 1 & 2, T35N, R7E) and at another Owens-Illinois stand of similar size and age in Oneida County (Sec. 3 & 4, T36N, R5E). An aerial survey on July 8 revealed that 300 acres were dead and dying at the Lincoln County site and 300 acres dead or dying at the Oneida County site. Two additional areas each about 20 acres in size were observed in Oneida County during the survey (Figure 11).

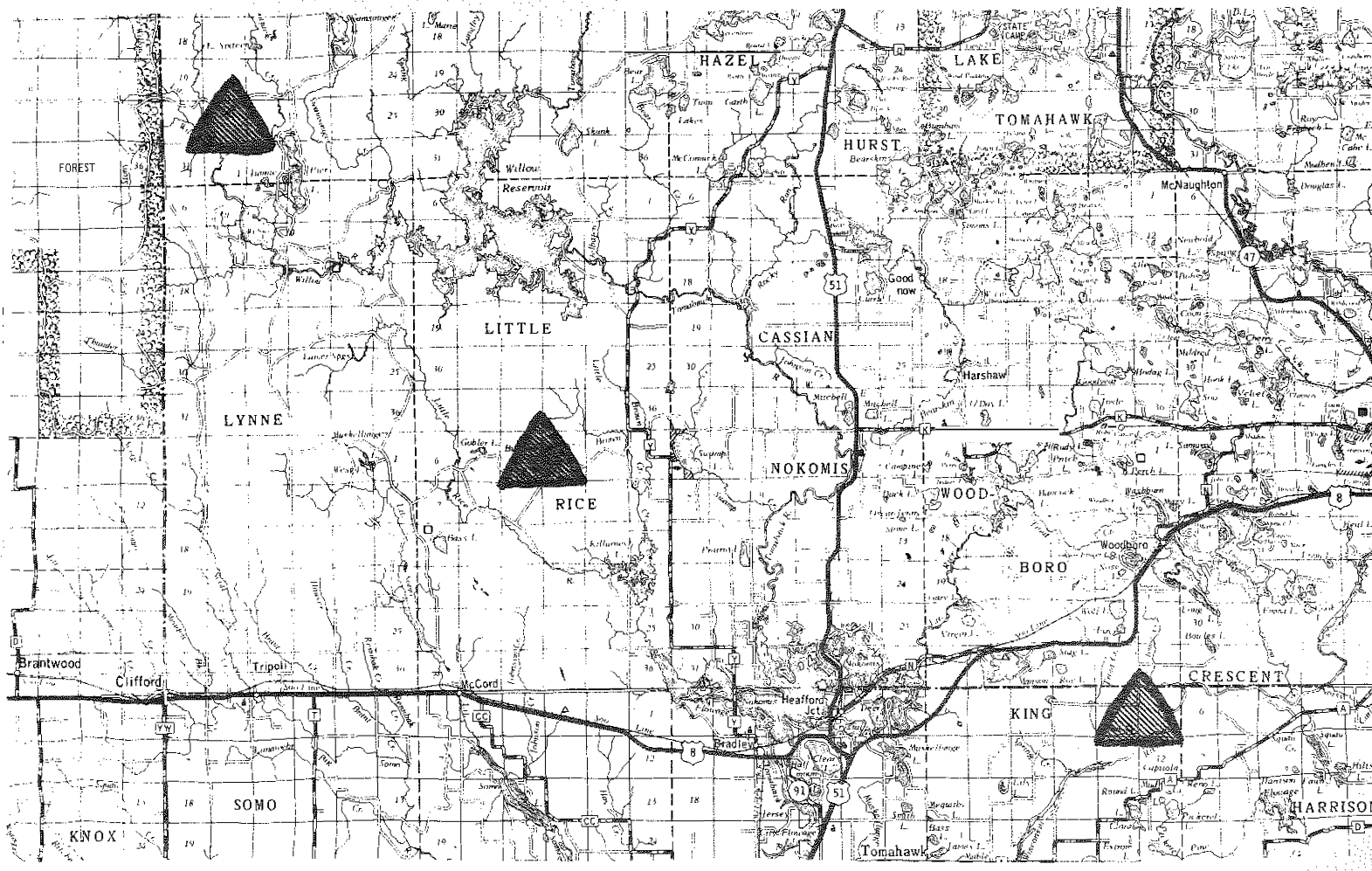


Figure 11. Aspen mortality in north central Wisconsin - 1977.

Dying aspen were examined on July 27 and specimens collected. The roots of dying trees were alive but the stems were dead or dying from the top. Cytospora canker (*Cytospora chrysosperma*) was present on several stems. Also present was the bronze poplar borer (*Agrilus liragus* B. & B.). Both of these pests invade weakened or dying trees indicating that some environmental factor such as the 1976 drought may have contributed to tree mortality. Sapling pin cherry, hazel and willow were also dead or dying at the Langlade and Oneida County sites. Later in the summer (August 30) tree mortality increased within the affected areas but did not spread beyond the original boundaries observed on July 8.

Balsam Fir Mortality - Drought

Balsam fir mortality was observed in Langlade County in April. Pole-size trees were primarily affected. Dying trees occurred occasionally in pockets but were usually at random throughout the stand. Tree mortality occurred on high ground and also in lowland areas and swamps. Needles of affected trees were red and the stems dry with the absence of pitch under the bark. No bark beetle galleries were observed but stem borers were found in one tree. Main lateral roots were healthy but feeder roots and mycorrhizae were dead. Tree mortality was attributed to the drought of 1976.

Basswood Bud and Leaf Damage - Unknown

Basswood failed to leaf out normally on an area of approximately 13,000 acres in Rusk Co. (Figure 12). A similar condition was observed in LaCrosse County (Sec. 20, T15N, R6W). Overwintering buds were mostly dead and dried up. Leaves produced by the few buds that did break gave the trees an appearance of having been severely defoliated. The failure of trees to leaf out normally appeared to be related to drought conditions that had prevailed in this area and others, and possibly timely frosts. Consideration was being given to harvesting the basswood on the area involved in Rusk County. However, the trees recovered well as the summer progressed.

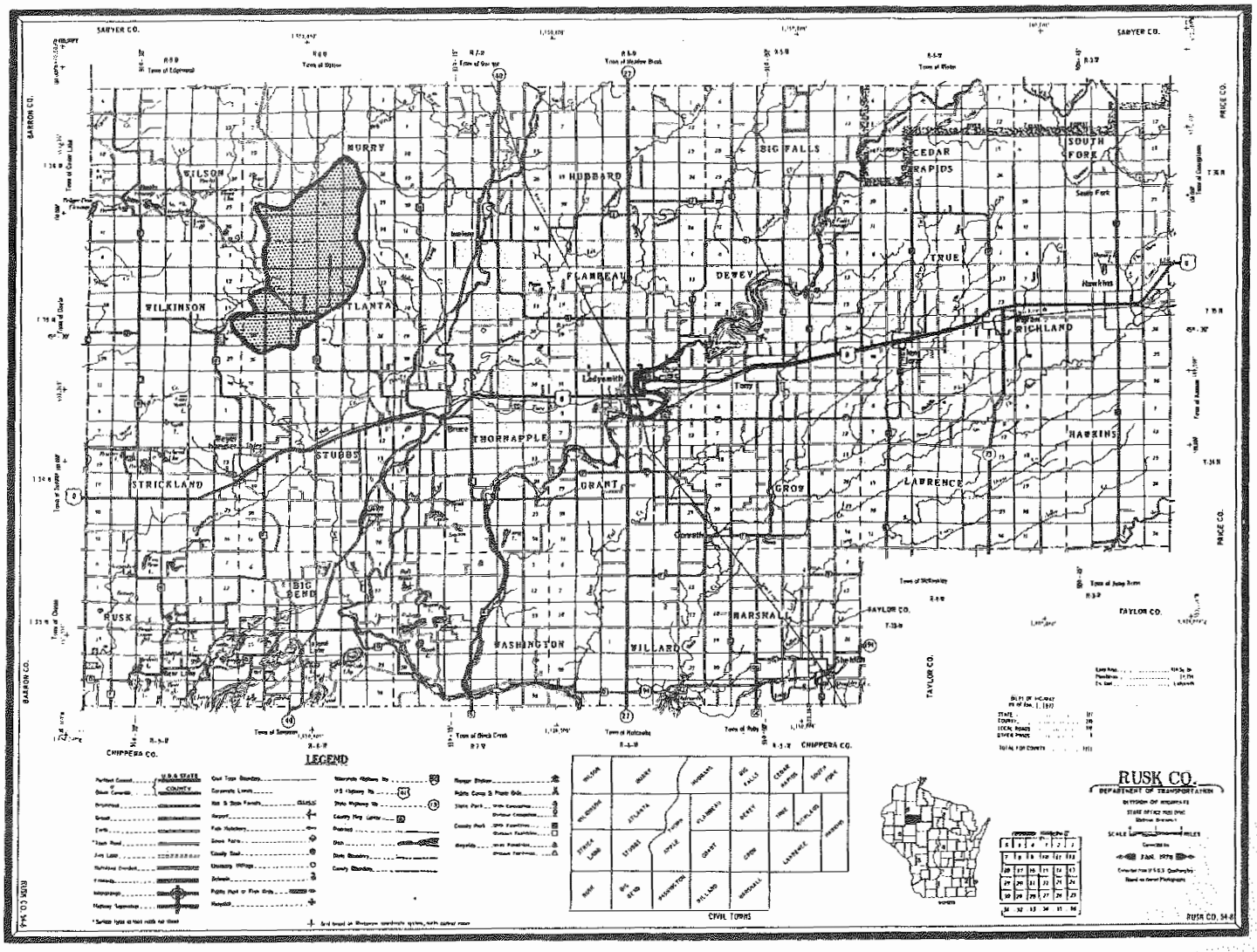


Figure 12. Basswood bud and leaf damage - Rusk Co. 1977.

Blowdown

A July 4 storm with winds of more than 100 miles per hour cut a path 17 miles wide and 166 miles long covering an area of 838,000 acres, including 527,700 acres of commercial forest land (Figure 13). The timber blown down included 75.8 million bd. ft. of sawlogs and 1.1 million cords of pulpwood. On the Flambeau River State Forest, a 2,000 acre tract of high value, old growth northern hardwood was flattened. By the end of the growing season, no evidence was found of wood borer invasion of the hardwood. The blown down pine was lightly attacked by *Ips pini*. Most of the brood emerged before winter and will be available to attack damaged pine in the spring of 1978. Many pole sized hardwood and pine were bent over to varying degrees. Many were too small for salvage and were mixed with standing trees. Some of these will probably be killed by borers but many may survive to cause management problems in the future.

A 100 acre blowdown was discovered during an aerial survey near Legend Lake in Menominee County (center of Sec. 34, T29N, R16E). About 1.5 million bd. ft. of white pine and hemlock was salvaged.

Fire

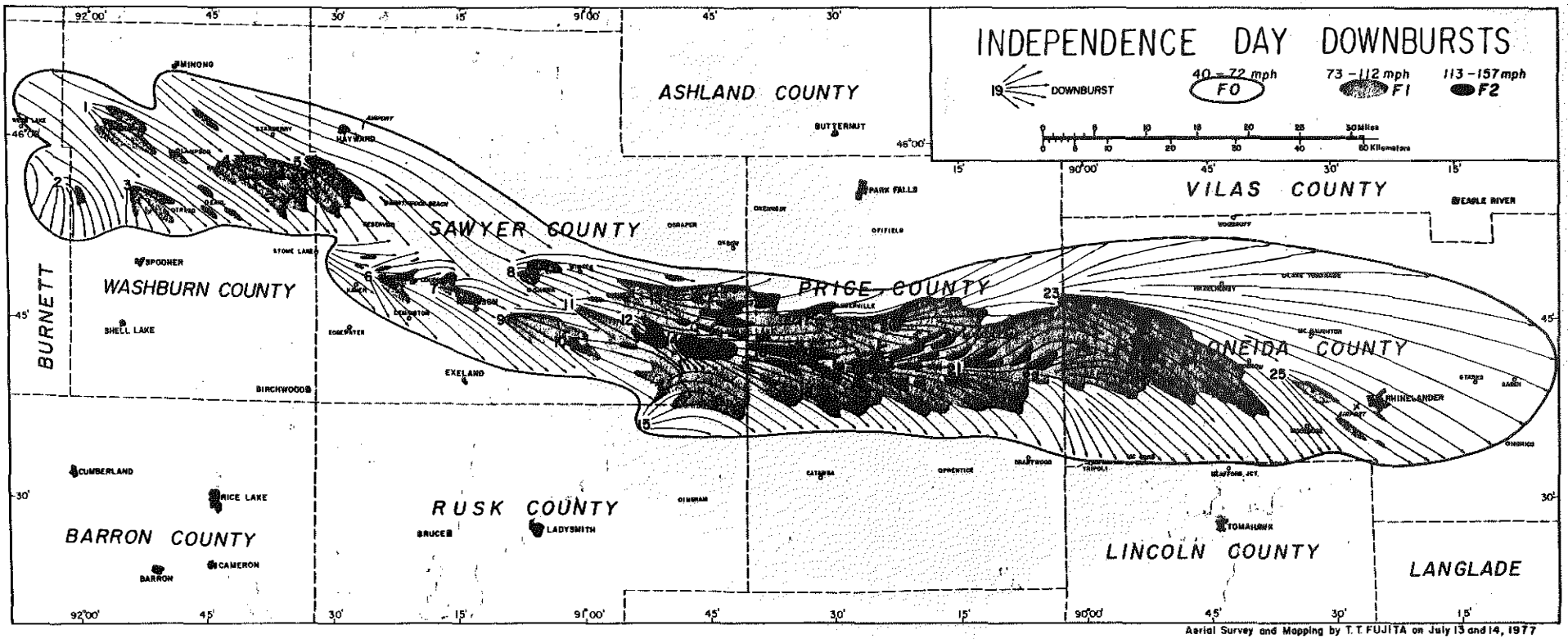
There were 1,824 fires through November that destroyed timber on 48,018 acres of forest land. Major ~~fires occurred during~~ April and May in Jackson County (20,000 acres) and another which started in Washburn County and continued northward into Douglas County burned 16,000 acres of timber. Wood borers and bark beetles moved quickly into the burned timber. Wood borers had penetrated to the heartwood of 8" diameter red pine by August.

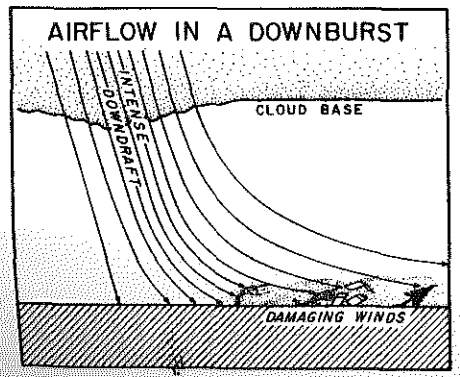
Salt Damage

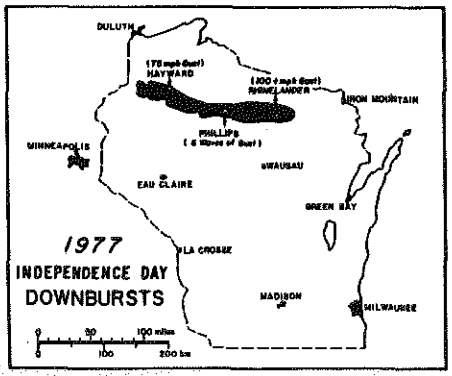
Damage caused by use of salt on highways was intensified by the lack of moisture and declining and dead trees were numerous along most main roads in northwest Wisconsin.

Winter Injury

Several plantations of red pine in Douglas and Bayfield counties were very red in the spring due to the weather. However, most buds were not damaged and new growth developed normally.







On INDEPENDENCE DAY, the 4th of July 1977, a severe thunderstorm moved across Northern Wisconsin. It was reported that there were extensive areas of tree and property damage, somewhat like that of an oversized tornado.

In cooperation with the National Weather Service Milwaukee Office and the National Severe Storms Forecast Center, Fujita made an aerial survey, mapping both direction and F-scale intensity of damaging winds. No evidence of a tornado was found anywhere inside the damage swath which was 166-mile long and 17-mile wide. Instead, there were scattered local centers from which straight-line winds diverged out violently. These local wind systems were identified as downbursts and numbered 1 through 25.

A downburst, designating downward rush of air current with horizontal outflow, is a downdraft of an extreme intensity accompanied by damaging winds on the ground. Although most downdrafts are not damaging at the surface, a downburst could cause severe damage which was evidenced in Northern Wisconsin on Independence Day.

Figure 13. Blowdown - Northern Wisconsin - July 4, 1977

APPENDIX A

FOREST DISEASE RESEARCH
Projects in Wisconsin - 1977
Wisconsin Department of Natural Resources
North Central Forest Experiment Station, USDA - Forest Service

Project Coordination

DNR - Allen J. Prey
Forest Pathologist
DNR, 3911 Fish Hatchery Road
Madison, Wisconsin 53711
Phone:

USFS - Thomas H. Nicholls
North Central Forest Experiment Station
USDA - Forest Service
Folwell Avenue
St. Paul, Minnesota 55101
Phone: 612-645-0841

Disease Project		Location	Contact
Jack Pine Needle Cast (*Davisomycella ampla*)	1.	Northern Highland State Forest Vilas County	Ralph Hewitt 715-584-2600
	2.	Black River State Forest Jackson County	Frank Morse 715-284-5301
Butternut Canker	1.	Blue Mounds State Park Dane County	Bruce Hensen 608-266-6926
	2.	Coulee Experiment Forest La Crosse County	Adrian Hagen 608-788-2534
	3.	Thunder Mountain State Park Marinette County	Gary Holzbauer 715-757-3541
Hybrid Poplar Leaf Rust (*Melampsora medusae*)	1.	Nevin Hatchery Madison, Wisconsin	Bruce Hensen 608-266-6926
Pine Tip Blight (*Diplodia pinea*)	1.	Black River State Forest Jackson	Frank Morse 715-284-5301
	2.	Griffith Nursery Wisconsin Rapids, Wisconsin	Ken Wojahn 715-423-5670
	3.	Hayward Nursery Hayward, Wisconsin	John Borkenhagen 715-634-2717
	4.	Hayden Plantations Green County Brodhead, Wisconsin	Paul Pingrey 608-325-2922
Red Pine Shoot Blight (*Sirococcus strobilinus*) Established - 1973	1.	Northern Highland State Forest Vilas County	Ralph Hewitt 715-584-2600

APPENDIX B

Biological Control Program
by
David J. Hall[1/]

I. Parasite Survey

A. Collections - Regular collections of immature insects were made every two weeks at all permanent monitoring locations except Pelican Lake. Populations of defoliators were very low in all locations, presumably due to the 1976 drought. About 1700 immatures were collected.

Malaise traps were placed at all seven locations. More than 80 pints were delivered to the Entomology Department, UW-Madison.

B. Larval Identifications - The larval reference collection now holds about 670 specimens; 257 are named to genus or species.

C. Rearing - The number of reared adult Lepidoptera and Hymenoptera was less than half of last year. Again, many immatures were placed in cold treatment in November and incubated in January.

D. Adult Identification - Reared adult hosts and parasites are identified at the Department of Entomology, UW-Madison. A preliminary list of 159 species of Lepidoptera reared was prepared (see Krauth et al., 1977A). Additional species have been reared since publication. Many of these species are new Wisconsin records (see Krauth et al., 1977B).

A preliminary list of parasites reared was published (see Krauth et al., 1977C). *Compsilura concinnata* (Meigen) was reared from larvae collected in Fond du Lac and Oneida counties. A list of Braconid genera from reared and malaise trap material was also prepared (see Shenefelt et al., 1977). The list presents 148 genera - twice the number previously recorded from Wisconsin. The total number of known Braconid species in Wisconsin will probably triple. One specimen of *Meteorus pulchricornis* Wesmael was recovered.

II. Parasite Releases

A. *Compsilura concinnata* (Meigen). Arrangements were made for a release in the City of Appleton before it was known that this species was already present in the general area. Of 200 adults received, about 15 were alive to emerge from the shipping container in Appleton on May 27.

B. *Lophyroplectus luteator* (Thunberg). Prespinning larvae of *Neodiprion sertifer* (Geoffrey) were field collected on Manitoulin Island, Ontario, by Dr. L. A. Lyons of the Canadian Forestry Service. The larvae were allowed to cocoon in paper bags, the adults emerged, and the remaining cocoons were placed in cold storage. The cocoons were delivered to Mark Kraemer, graduate student, UW-Madison, who incubated them on April 17, at 20°C. Adult *Lophyroplectus luteator* began emerging May 18.

A total of 408 males and 305 females were released on three separate dates--May 23, 25 and 29, 1977. All were released in a heavy European pine sawfly infestation in a red pine planting on the southern unit, Kettle Moraine State Forest near La Grange in Walworth County (SWSW, Sec. 10, T4N, R16E). The planting is about 12 years old, the trees range from 4 to 15 feet tall. Parts of the planting are fully stocked and parts have less than 100 trees per acre--ideal for sawfly populations. Some trees contained 20 colonies. Most of the larvae were in the 5th instar at the time of the first release.

The adult parasites were released between 9 and 11 a.m. on each date. The sky was sunny to hazy; temperatures, 75-85°F; RH 70-75%; winds light. Release cages were opened in the shade. Most parasites had left the cages within an hour of opening; they left rapidly when exposed to direct sunlight. Mating was frequently observed in the cages and on the pine foliage. Active searching was observed near sawfly colonies. Some apparently successful oviposition attempts were observed and photographed.

Voucher specimens were delivered to the University of Wisconsin Insectarium.

[1/] Forest Entomologist and Biological Control Specialist, Wisconsin Department of Natural Resources, Madison, WI 53711.

APPENDIX C

Diplodia pinea pathogenic to *Pinus resinosa*
by
Thomas H. Nicholls, Michael E. Ostry & Allen J. Prey

Presented at: The American Phylopathological Society, 69th Annual Meeting, August 14-19, 1977, East Lansing, Michigan.

ABSTRACT

Diplodia pinea pathogenic to *Pinus resinosa*. Thomas H. Nicholls, Michael E. Ostry, North Central Forest Experiment Station, 1992 Folwell Avenue, St. Paul, Minnesota 55108; and Allen J. Prey, Dept. of Natural Resources, 3911 Fish Hatchery Road, Rt. 4, Madison, Wisconsin 53711.

The fungus *Diplodia pinea* (Desm.) Kickx. is the cause of a relatively common tip blight that kills needles and shoots at the tips of living pine branches. Serious damage including tree mortality has occurred on numerous species of hard pines in several areas of the world. Recent outbreaks of this disease have been noted on several thousand acres of red pine, *Pinus resinosa* Ait., in Minnesota and Wisconsin in windbreaks, nurseries, Christmas tree plantings, plantations and on ornamentals. Pitch-soaked girdling cankers are produced under the bark of affected trees killing individual branches, tops of trees, or entire trees. Recent drought conditions in the two states may have weakened some trees making them more susceptible to infection. Fruiting bodies are produced on cones, needles, shoots, branches, and tree boles. Spores infect trees through wounds caused by such agents as hail, insects, and Christmas tree shearing. Field evidence indicates that infection can also occur without wounds. This was confirmed in greenhouse inoculation tests with red pine that showed *D. pinea* to be a primary pathogen. The fungus grows rapidly in culture with optimum growth at 30°C. *In vitro* tests with four fungicides revealed benomyl, (Methyl 1-butylcarbamoyl)-2-benzimidazolecarbamate, to be the most effective at 0.1 ppm.

APPENDIX D

Evaluation of Fungicide Sprays to Control Damping-off
of Red Pine Seedlings in Wisconsin's Forest Tree Nurseries
by
John G. Berbee[1/] & Jane (Peronto) Zarnstorff[2/]

Damping-off organisms continued to cause mortality in 1-0 red pine seedlings at Griffith, Hayward and Wilson state nurseries. In a cooperative project between the University of Wisconsin Department of Plant Pathology and the Department of Natural Resources, spray trials were initiated in all the nurseries using various concentrations of the fungicides thiram (Tersan 75), captan, benomyl (Benlate) and combinations of captan and benomyl.

The objectives of the fungicidal spray trials were as follows:

a) Determine for each of the three DNR nurseries the extent of damping-off and root rot loss currently being caused by specific pathogenic soil-borne fungi.

b) Determine the effectiveness of three concentrations of thiram, captan, benomyl and captan combined with benomyl in the control of damping-off and root rot caused by *Rhizoctonia solani, Cylindrocladium floridanum* and *Fusarium oxysporum f. pini*.

c) Monitor the effects of the various treatments on the growth and development of red pine seedlings and the development of mycorrhizae.

d) Generate the data base required to obtain legal clearances for the use of effective fungicidal treatments.

e) Provide DNR nursery managers with a written summary of results by 8/31/77.

In order to evaluate the extent of damping-off and root rot and the effects of the fungicidal sprays on the seedlings, seven parameters were studied. They were: mortality, height, weight, shoot-root ratio, percent mycorrhizal roots, percent stunting and percent of isolations identified as *Rhizoctonia, Cylindrocladium* and *Fusarium*.

[1/] Professor, Dept. of Plant Pathology, University of Wisconsin, Madison, WI.
[2/] Technician, Dept. of Natural Resources, Madison, Wisconsin.

Samples and data were collected once in May and once in June at each nursery. A stand inventory of the red pine seedlings was taken twice during the growing season at each nursery. Analysis was done at the University of Wisconsin Department of Plant Pathology.

The stand inventories revealed that Wilson Nursery seedlings had 14% or greater mortality due to damping-off and root rot in all treatment and check rows (Table 1). Because of the variability in the results, no conclusions can be drawn about the control value of the different treatments. Not enough damping-off occurred at Griffith and Hayward nurseries to determine the effects of the spray treatments.

Average heights and weights of one hundred seedlings per treatment were calculated at all three nurseries and no apparent detrimental effects from the sprays were noted on the heights, weights and shoot-root ratios (Table 2). Hayward seedlings were smaller compared to Griffith and Wilson seedlings which may have been due to a shorter growing season.

The development of mycorrhizae on 1-0 red pine seedlings in treatment and check rows was examined at Griffith Nursery (Table 3). There is an indication that benomyl and the low concentration (24 lb active/A) of thiram increase the development of mycorrhizae. The high concentration (96 lb active/A) of thiram seemed to decrease the amount of mycorrhizae development. The other treatments had no apparent detrimental effects on mycorrhizal development.

Stunting incidence was studied at all three nurseries (Table 4). The combination of benomyl (8.9 lb active/A) and captan (24 lb active/A) yielded fewer stunted seedlings at all three nurseries.

At each nursery, samples were collected for isolation of possible pathogenic fungi, once in May and June. *Rhizoctonia solani* was isolated more frequently in May than in June at all three nurseries. *Fusarium oxysporum* was isolated more frequently in June than in May (Table 5). The remaining isolates including species of *Alternaria* and *Penicillium* were judged nonpathogenic. *Rhizoctonia* and *Fusarium* were the only fungi isolated that were considered pathogenic.

Recommendations and Work Planned

Results of this work suggest that alternatives to fungicidal seedbed sprays should be considered for control of damping-off. Fungicidal seedcoat treatments with benomyl, captan and thiram and combinations of these are recommended for trial testing. Collection of data on the results of the trials might then be used for registration of the fungicides. Fumigation trials of Methyl Bromide and Mylone should be evaluated for efficacy of controlling the damping-off pathogens. Various concentrations of the fumigants should also be analyzed for determining the best concentration for control of pathogens without adversely affecting seedling growth and development.

TABLE 1. Effect of Fungicidal Sprays on 1-0 Red Pine Seedling Mortality Due to Damping-off at Wilson State Nursery (Boscobel, WI).

Fungicide(s)	Conc./A (lb active)	Density Initial Stand (Seedlings/ft^2)[1/]	Mortality[2/] Seedling (%)
Thiram	24	40	15
Thiram	48	38	21
Thiram	96	84	55
Captan	24	48	47
Captan	48	43	37
Captan	96	65	40
Benomyl	8.9	44	31
Benomyl	17.8	41	17
Benomyl	35.7	41	14
Benomyl & Captan	Benomyl 4.5 Captan 12	71	38
Benomyl & Captan	8.9 24	76	39
Benomyl & Captan	17.8 48	43	20
None (check)		41	26
None (check)		90	52
None (check)		46	32
None (check)		41	19
Thiram	Nursery Spray[3/]	45	20

[1/] Based on 10 (1.428 ft^2) samples per treatment which equals 29.7% of a 12' x 4' seedbed.
[2/] Through June 14, 1977.
[3/] 30 lbs. active/A.

TABLE 2. Effect of fungicidal sprays on the average size and shoot/root ratios of 1-0 red pine seedlings at 3 State Nurseries.

Fungicidal spray			State Nursery: Griffith			Hayward			Wilson		
Fungicide	Conc/A (lb active)		Height (cm)	Dry weight (g)	Shoot/ root ratio	Height (cm)	Dry weight (g)	Shoot/ root ratio	Height (cm)	Dry weight (g)	Shoot/ root ratio
Thiram	24		9	.488	6.8	5.5	.18	3.8	9	.487	6.7
Thiram	48		8.3	.508	6.8	6.2	.26	4.1	5.9	.313	4.5
Thiram	96		8.8	.473	6.8	6.0	.188	4.5	8.3	.395	6.3
Captan	24		9.1	.502	6.8	5.7	.199	4.3	8.6	.390	7.6
Captan	48		8.6	.541	6.2	5.6	.188	4.1	7.4	.405	5.7
Captan	96		8.9	.517	6.5	5.9	.210	4.0	7.3	.328	4.7
Benomyl	8.9		8.5	.51	6.6	5.8	.197	4.3	7.6	.427	5.4
Benomyl	17.8		8.6	.494	6.5	6.0	.210	4.3	8.4	.399	6.2
Benomyl	35.7		8.6	.448	7.1	5.3	.18	4.3	8.4	.42	6.3
	Benomyl	Captan									
Benomyl + Captan	4.5	12	8.1	.440	6.0	5.3	.15	3.3	8.0	.376	5.3
Benomyl + Captan	8.9	24	8.8	.537	7.1	6.3	.231	5.0	8.6	.413	6.4
Benomyl + Captan	17.8	48	8.6	.422	7.0	5.7	.208	4.5	8.8	.423	5.9
None (check)			8.6	.505	6.5	5.2	.139	3.2	6.5	.391	5.0
None (check)			8.4	.507	6.1	4.8	.134	3.4	8.2	.351	5.7
None (check)			8.3	.473	6.3	5.9	.205	4.3	8.6	.462	6.7
None (check)			8.8	.448	7.1	5.5	.194	4.1	8.7	.442	6.4
Thiram	Nursery spray[1/]		8.8	.519	7.1	5.3	.155	3.5	8.4	.410	5.8

[1/] 30 lbs. active/A.

TABLE 3. Effect of various fungicidal sprays on the development of mycorrhizae in 1-0 red pine seedbeds at Griffith State Nursery.

Fungicidal spray			Lateral roots with mycorrhizae[1/] (%)	Short roots mycorrhizal[2/] (%)
Fungicide	Concn/A (lb active)			
Thiram	24		71	66
Thiram	48		48	51
Thiram	96		29	47
Captan	24		49	43
Captan	48		51	63
Captan	96		51	54
Benomyl	8.9		84	72
Benomyl	17.8		65	61
Benomyl	35.7		73	67
	Benomyl	Captan		
Benomyl + Captan	4.5	12	52	62
Benomyl + Captan	8.9	24	49	69
Benomyl + Captan	17.8	48	66	45
None (checks, 4 rows)			59 ± 11	66 ± 12
Thiram	Nursery spray[3/]		55	

[1/] Based on examination of 50 trees per row and 6 lateral roots per tree.
[2/] Based on examination of short roots on 25, 1 cm lateral root sections per row.
[3/] 30 lbs. active/A.

TABLE 4. Effect of various fungicidal sprays on the incidence of stunting in 1-0 red pine seedbeds at 3 State Nurseries.

Fungicidal spray			State Nursery		
			Griffith	Hayward	Wilson
Fungicide	Concn/A (lb active)		Seedlings stunted[c] (%)	Seedlings stunted[c] (%)	Seedlings stunted[c] (%)
Thiram	24		33	21.8	3.6
Thiram	48		3.8	1.4	10.9
Thiram	96		31.4	16.1	43.1
Captan	24		20.4	17.3	19.2
Captan	48		7.2	6.0	31.3
Captan	96		7.8	4.9	11.1
Benomyl	8.9		4.1	5.5	39.5
Benomyl	17.8		12.3	1.1	23.9
Benomyl	35.7		27.4	2.9	4.9
	Benomyl	Captan			
Benomyl + Captan	4.5	12	.15	20.8[b]	2.7
Benomyl + Captan	8.9	24	.94	1.3	3.9
Benomyl + Captan	17.8	48	10.3[a]	9.6	4.1
None (check)			3.8	31.2	21.3
None (check)			7.1	41.9	24.1
None (check)			21.5	2.3	14.5
None (check)			17.9	16.9	12.6
Thiram	Nursery spray[d]		15.0	38.6	20.2

[a]The rows adjacent to this row have seedling stunted percentages of 17.9 and 20.4.
[b]The rows adjacent to this row have seedling stunted percentages of 38.6 and 31.2.
[c]Based on 35 1.428 ft^2 samples per treatment which equals a 1.6% sample of a 4' x 552' seedbed row.
[d]30 lbs. active/A.

TABLE 5. Frequency of Isolations Identified as *Rhizoctonia solani*, *Fusarium oxysporum* and Other Fungi from Damped-off Seedling at Griffith, Hayward and Wilson State Nurseries.

	NURSERY					
	Griffith[a/]		Hayward[b/]		Wilson[c/]	
	May Frequency of %	June Isolations %	May Frequency of %	June Isolations %	May Frequency of %	June Isolations %
Rhizoctonia	14	11	12	3	15	4
Fusarium	19	24	19	36	42	65
Other[d/]	67	65	69	61	43	31
Total	100	100	100	100	100	100

[a/]140 seedlings sampled in May, 92 in June.
[b/]84 seedlings sampled in May, 147 in June.
[c/]168 seedlings sampled in May, 158 in June.
[d/]Including bacteria, *Alternaira* sp., *Aspergillus* sp., *Penicillium* sp., and unidentified fungi.